View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Elsevier - Publisher Connector

Available online at www.sciencedirect.com

ScienceDirect

Procedia Social and Behavioral Sciences 2 (2010) 2539–2543

Procedia
Social and Behavioral Sciences

WCES-2010

The impact of an education program about evolution on the shift from teleological to evolutionary explanations among Belgian children around the age of ten

Maex, J.[a] *, De Laet, A.[a], De Backer, C.[b], Blancke, S.[b], Braeckman, J.[b], De Meyere, J.[a]

[a]*Katolieke Hogeschool Kempen,Geel 2440, Belgium (Katholieke Hogeschool Kempen University College)*
[b] *Ghent University, Ghent 9000, Belgium*

Received October 21, 2009; revised December 30, 2009; accepted January 12, 2010

Abstract

It has been shown that in the U.S. and in the U.K. children up to the age of ten adhere to teleological explanations for the existence of living and non-living objects. Around the age 10 children tend to shift away from being "intuitive theists" to hold a stronger belief in evolution as the driving force behind the emergence and evolution of life on earth, including the emergence and evolution of human mankind. To test whether these results replicate in different cultures, we set up a similar study in Belgium, as a next study case to support these claims cross-culturally.
© 2010 Elsevier Ltd. Open access under CC BY-NC-ND license.

Keywords: Science education ; evolutionary theory ; teleological explanations ; cognitive inhibitions ; child development.

1. Introduction

Creationists are renowned for turning evolutionary theory into a straw man laced with misconceptions. Extensive research in the United States, however, has repeatedly found that not only creationists but many non-fundamentalist students and even biology teachers hold persistent misconceptions about evolutionary theory (Bardapurkar, 2008; Gregory, 2009). For instance, they often perceive natural selection as a mechanism driven by an individual organism's need instead by environmental pressures working over a population containing random variation. Recent research in the UK (Cleaves & Toplis, 2007; McCrory & Murphy, 2009) and South-Africa (Sanders & Ngxola, 2009) indicates that misunderstanding evolutionary theory is not exclusively connected to the exceptional religious context in the US. Of course, cultural, social, and religious factors do influence one's understanding of evolutionary theory, but both the persistence of the misconceptions and their universal appeal, add to the idea that cognitive factors play an important role as well.

Research into the cognitive development of children indeed suggests that humans fall victim to misconceptions about evolutionary theory quite easily– or refuse to accept the validity of the theory altogether – because the human

* Joke Maex. Tel.: +3214508160; fax: +3214508161
E-mail address: joke.maex@khk.be

1877-0428 © 2010 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
doi:10.1016/j.sbspro.2010.03.369

mind is more prone to embrace essentialist, teleological and creationist explanations than scientifically informed, natural ones. Deborah Kelemen (1999a, 1999b, 2003), for instance, has demonstrated repeatedly that young children are, what she calls, "promiscuously teleological". This means that "in the absence of physical-mechanical knowledge, scientifically naïve children will default to an artifact model and, unlike contemporary Western-educated adults, explain the properties of both living and non-living natural kinds in terms of a purpose." (Kelemen, 2003; our italics) Interpreting both the living and nonliving natural world in terms of purpose (teleo-functional thinking) has been demonstrated with American and British children (Kelemen, 1999a, 1999b, 2003). Research with educated adults replying under speeded conditions, with uneducated Romani adults and with Alzheimer patients (Casler & Kelemen, 2008; Kelemen, 2003; Lombrozo, Kelemen, & Zaitchik, 2007) seem to confirm that teleo-functional reasoning comes natural to the human mind, acting as a default setting that can only be replaced, but not removed, by science education (Kelemen, 2004).

Another interesting line of research has been followed by E. Margaret Evans. She explored how children in elementary school thought about the origin of species. In one study conducted with children of three different age groups, she found a "coherent developmental pattern". The youngest group, with a mean age of 6.9 years, resorted to a mix of creationist and spontaneous generationist explanations; the middle group, with a mean age of 8.8 years, rendered exclusively creationist explanations and the old age group, with a mean age of 11.7 years, supplied either exclusively creationist or evolutionist explanations. Therefore, Evans had found two distinct developmental shifts: "a shift from mixed creationist and spontaneous generationist beliefs to an exclusive creationism, and from there to exclusive creationist or exclusive evolutionist beliefs." (Evans, 2000b) In another study with similar age groups, but now including children from fundamentalist school communities, she found that "naturalistic responses (evolution and spontaneous generation) are rarely endorsed. This is unlike the pattern for the non-fundamentalist population where the dominant response depended on the age of the participants."(Evans, 2001) Evans regards the contagiousness of creationist ideas as the result of a mix of cognitive and contextual factors. As she noted elsewhere (Evans, 2000a), "creationist beliefs are both intuitively attractive and culturally available; evolutionist beliefs are less so. Availability is determined by cultural or societal processes, attractiveness by cognitive processes."

Essentialism, teleology and intention are the main cognitive predispositions Evans assumes to shape children's intuitive reasoning on the origin of species. Because of the presence of these three predispositions in children's minds, Kelemen (2004) describe children as "intuitive theists". Essentialism is the idea that biological species contain an immutable essence and, therefore, hinders people's acceptance of evolution (Gelman, Coley, & Gottfried, 1994). Teleological thinking and thinking in terms of intention are often linked together, but they can be disassociated (Evans, 2001; Kelemen & Di Yanni, 2005). Kelemen and Di Yanni, however, found support for the idea that within children's minds "thoughts about purpose in nature are related to their ideas about intelligent design in nature." (Kelemen & Di Yanni, 2005) Interestingly, like Evans, they also found evidence for a cognitive shift that occurs in children's minds around 9 to 10 years of age "as they increasingly retain and elaborate physical-causal explanations that are alternatives to teleofunctional and design explanations of the biological and nonbiological world."(Kelemen & Di Yanni, 2005)

Therefore, both Kelemen and Evans have documented a cognitive shift around ten years of age from creationist to evolutionist explanations. For now, however, this research has only been done with American and British children. To see whether this mind shift also occurs within a different environment, we investigated Belgian children's ideas on the origin of the natural world between the age of 9 and 12. We also wanted to check whether an education program about evolutionary theory could have any influence on this mind shift. Given the persistence of essentialist, teleological and intentional thinking within the minds of children under ten years of age, we expected to find that, even after being taught about evolutionary theory, they would still be more inclined towards creationist explanations than the older children.

2. Methodology

2.1. Survey

To test our hypothesis we made use of a quantitative survey. The survey consisted of two parts. In a first part we asked questions about general knowledge with regards to evolutionary theory, and questions to measure the

respondents' attitudes towards evolutionary theory, creationism and intelligent design. The knowledge questions were formatted in multiple choice answers, while the attitude questions were measured on 1-4 likert scales.

In a second part we used the Post Critical Belief Scale to measure the respondents' religious profile. The Post Critical Belief Scale (Duriez, Dezutter, Neyrinck, & Hutsebaut, 2007; Hutsebaut, 2001) identifies four types of religious cognitive styles which highly influence the way in which people deal with religious representations and narratives. The four types are orthodoxy, external critique, relativism, secondary naïveté. In the project of K.H.Kempen University College "Empirical research on the religious development of children in a pluralistic context" the Post Critical Belief Scale was adjusted to the level of children between 10 to 14 years old (2005-2008). This adjusted scale was used in the project of KHK University College "Seeing more in evolution" to evaluate the influence of the religious cognitive styles on the acceptation or rejection of evolutionary theory.

2.2. Participants

In total, 121 children completed the surveys. All participants were recruited at schools and completed the surveys after we got permission from teachers and parents to take part in this study. The surveys were filled out in class, in the presence of the children's teacher. In total, 57 boys and 64 girls participated, all of whom self-reported a catholic orientation. The age of the children varied from 9 to 13, and their mean age was 11.27 (s.d.= 0.97).

2.3. Procedure

The surveys were distributed at 14 primary schools in the Belgian region of the Kempen in the period April and June 2009. The selected schools are public as well as Catholic elementary schools.

Two weeks after the children completed the survey, during which time they were taught an introduction to evolutionary theory, we redistributed the first part of the survey to test whether their knowledge about and attitude towards evolutionary theory had shifted due to the teaching program.

3. Results

Fo all analyses we split our file, dividing the children in a group of age 'minor ten'and a group of 'ten and up'.

With regards to the questions we asked to measure the children's knowledge about evolution, intelligent design and creationism, in part 1 of survey 1, we noticed that, in general, the minus ten year olds give answers that support the belief that God created the world, while the children aged ten and up answered the knowledge questions more in support of evolutionary theory. For instance, when asked "Do species of plants and animals evolve over time", the older children answered more "yes", while the younger children gave more "no" as an answer (91.8% vs. 77.1%, $p<0.05$ Mann Whitney).

When asked whether plants and animals were "designed by God", more of the younger children answer "yes" (42.9% vs. 20.2%, $p<0.05$ Mann Whitney). Also, when asked whether "planet earth was created by God a long time ago" the younger children were more inclined to answer positively (48.6% vs. 24.1%, $p<0.01$ Mann Whitney). With regards to the question "why do peacocks have such beautiful long tails", the majority of the older children answer that "evolution is the driving force" (89.3%), 6% thinks "someone designed it" and 4.8% believes God is the designer. Among the younger children the answers are a little more spread over the different options; only 65.7% thinks the evolutionary answers is correct, while 22.9% is sure that God designed the peacock's tail and the remaining 11.4% thinks someone else is behind this piece of beauty (intelligent design idea).

Confronted with the statement "according to the bible God created the animals on day five. On day six God created the humans", the majority (79.8%) of the older children reply (multiple choice options) that "the bible is no scientific explanation to explain the existence of life on earth" while the answers of younger children were significantly ($p<.05$, Mann Whitney Test) more spread over this option and the alternative answer that "as animals and humans were created on different days, there is no possibility that animals and humans could have ever evolved from common ancestors" (45.7% answers the latter).

Lastly, asked why "sharks and dolphins resemble each other despite the fact that the first are fish and the latter are mammals" almost all of the older children (93.7%) answer that "they look similar because the process of evolution has adapted their body shape to similar environments; living in the water", while a quarter of the younger

children (25.7%) believes that "they look similar because God designed them to look similar" ($p<0.01$, Mann Whitney).

When confronted with the same survey after the children were taught about evolutionary theory, we first noticed a closure of the gap between the two groups as the answers to the straightforward question if "planet earth was created by God a long time ago" grew more similar, with 34.3% of the younger children and 23.3% of the older children answering "yes"(this difference is no longer significant). However, for all other questions we noticed that the minus ten year olds still answered questions more into accordance of creationist beliefs than the children aged ten and up. Even for other simple, straightforward questions, such as plants and animals were "designed by God", the younger children still more significantly answered "yes" than the older children (31.4% vs. 11.9%, $p<0.05$ Mann Whitney).

With regards to the attitudes measured on 1-4Likert scales we saw no significant differences between both groups. There was a slight overall tendency of all children to agree less with creationist statements and to agree more with evolutionary thoughts, but the effect was minor.

At last, when controlling for the different types of Post Critical Beliefs, we could not find any significant differences between the groups.

4. Conclusion

Young children adhere to teleological explanations for the existence of living and nonliving entities, even after they are taught about physical explanations that can replace them. However, studies conducted with American and British children, suggest that this point of view alters around the age of 9 to 10, when these kids shift away from being "intuitive theists". Rather than attributing the existence of natural objects to the design of a non-human creator, children above the age of 10 seem to be more open to understanding and applying evolutionary explanations for the existence of living and nonliving objects (Kelemen, 2004). Education about evolution and other cultural influences might explain this phenomenon, but it might also be due to cognitive inhibitions that tend to weaken and/or disappear at this point in life (De Cruz & De Smedt, 2007).

We wanted (1) to test whether this mind shift applies to Belgian children as well, and (2) to explore the impact of educational programs about evolution on these children's understanding of and attitude towards evolutionary and creationist explanations for the world. Therefore, we supplied 121 children between age 9 and 13 with two identical surveys before and after a teaching program about evolution.

In general, the results indicate that the children up until the age of 10 adhere more strongly to creationist explanations of things, while the children aged 10 and up hold a stronger attitude towards evolutionary explanations. This difference stands even after the education program about evolution. Before and after the education program more +10 year olds than -10 year olds answer "yes" when asked if "species (plants and animals) change over time", and more -10 year olds than +10 year olds support the claims that "plants and animals are designed by God" and "a long time ago the earth was created by God". The +10 year olds do not regard the bible as a scientific explanation of life on earth, while the -10 year olds tend to regard it as 'proof' that humans and other animals cannot have descended from common ancestors.

This study is in line with the findings of previous studies in the U.S. and the U.K. (Kelemen, 1999a, 1999b, 2003), and we believe it would be interesting to further investigate whether these results occur cross culturally.

References

Bardapurkar, A. (2008). Do students see the "selection" in organic evolution? A critical review of the causal structure of student explanations. *Evolution. Education and outreach, 1*, 299-305.

Casler, K., & Kelemen, D. (2008). Developmental continuity in teleo-functional explanation: Reasoning about nature among Romanian Romani adults. *Journal of Cognition and Development, 9*(3), 340-362.

Cleaves, A., & Toplis, R. (2007). In the shadow of Intelligent Design: the teaching of evolution. *Journal of biological education, 42*(1), 30-35.

Duriez, B., Dezutter, J., Neyrinck, B., & Hutsebaut, D. (2007). An introduction to the Post-Critical Belief Scale. Internal structure and external relationships. *Psyke & Logos, 28*, 767-793.

Evans, E. M. (2000a). Beyond Scopes. Why creationism is here to stay. In K. Rosengren & C. Johnson & P. Harris (Eds.), *Imagining the impossible: Magical, scientific and religious thinking in children* (pp. 305-331). Cambridge: Cambridge University Press.

Evans, E. M. (2000b). The emergence of beliefs about the origins of species in school-age children. *Merrill-Palmer Quarterly-Journal of Developmental Psychology, 46*(2), 221-254.

Evans, E. M. (2001). Cognitive and contextual factors in the emergence of diverse belief systems: Creation versus evolution. *Cognitive Psychology, 42*(3), 217-266.

Gelman, S. A., Coley, J. D., & Gottfried, G. M. (1994). Essentialist beliefs in children: the acquisition of concepts and theories. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind. Domain specificity in cognition and culture* (pp. 341-365). Cambridge: Cambridge University Press.

Gregory, T. R. (2009). Understanding natural selection: Essential concepts and common misconceptions. *Evolution. Education and outreach, 2*, 156-175.

Hutsebaut, D. (2001). Post-critical belief scales. Exploration of a possible developmental process. *Journal of Empirical Theology, 13*, 19-28.

Kelemen, D. (1999a). The scope of teleological thinking in preschool children. *Cognition, 70*(3), 241-272.

Kelemen, D. (1999b). Why are rocks pointy? Children's preference for teleological explanations of the natural world. *Developmental Psychology, 35*(6), 1440-1452.

Kelemen, D. (2003). British and American children's preferences for teleo-functional explanations of the natural world. *Cognition, 88*(2), 201-221.

Kelemen, D. (2004). Are children "intuitive theists"? Reasoning about purpose and design in nature. *Psychological Science, 15*(5), 295-301.

Kelemen, D., & Di Yanni, C. (2005). Intuitions about origins: purpose and intelligent design in children's reasoning about nature. *Journal of Cognition and Development, 6*(1), 3-31.

Lombrozo, T., Kelemen, D., & Zaitchik, D. (2007). Inferring design - Evidence of a preference for teleological explanations in patients with Alzheimer's disease. *Psychological Science, 18*(11), 999-1006.

McCrory, C., & Murphy, C. (2009). The growing visibility of creationism in Northern Ireland: are new science teachers equipped to deal with the issues? *Evolution. Education and outreach, 2*, 372-385.

Sanders, M., & Ngxola, N. (2009). Identifying teachers' concerns about teaching evolution. *Journal of biological education, 43*(3), 121-128.